Review of the Snider Creek Steelhead Program

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Introduction

The Washington Department of Game (WDG) entered into a 25 year cooperative agreement with the Olympic Peninsula Guides Association (OPGA) on June 17, 1986,

> *"to provide a maximum of 100,000 winter steelhead smolts of wild Soleduck River stock annually for release into the Soleduck River. These fish shall be reared to release size (larger than 10 fish / pound) on OPGA managed facilities and are to be used to produce additional harvestable adult steelhead for commercial and sport fishermen on the Quillayute River system. Returning adults from this project will be considered hatchery fish for the purposes of harvest management."*

The OPGA was to draw broodstock each year from early returning Sol Duc wild steelhead, to be collected prior to February 1. Initially, returning marked females could also be used for broodstock. This was amended in 1998 to require that no more than 10% of the broodstocked females be returning Snider Creek-origin females, to comply with the proposed Wild Salmonid Policy. The target release was also reduced to 50,000 smolts during many years subsequent to 1998. The Snider program targeted early returning wild steelhead for broodstock on the assumption that returning adult Snider origin steelhead that escaped the fisheries would bolster the early portion of the wild steelhead return, which is typically subjected to higher exploitation rates than the later timed peak return of wild steelhead.

The Snider Creek cooperative agreement is due to expire in June of 2011. The Washington Department of Fish and Wildlife (WDFW) has initiated a review of the program to determine the best course of action regarding continuing the program as is, modifying it, or discontinuing the agreement. Available data have been gathered and analyzed to evaluate the performance of the Snider Creek program in the context of Sol Duc wild winter steelhead, and their potential interactions. These data were made available to interested parties through various formats for independent analysis of the program. A list of pertinent questions was provided with the data suggesting avenues for investigation. This paper seeks to address those questions to the extent the data allow. Other considerations also bear on the decision, such as the mandates and guidance of the Statewide Steelhead Management Plan, adopted by the Fish and Wildlife Commission in 2008.

Questions posed relative to the consideration for renewal or discontinuation of this program, and which this paper will attempt to address using the Snider Creek and Sol Duc data, are:

1. What is the contribution of Snider Creek production to the sport and tribal fisheries?
2. Is the Snider Creek program producing early timed returns, as intended?
3. What proportion of the early timed Sol Duc River natural steelhead return is being removed for broodstock?

4. How does the production from the program compare to the production that could be expected had the broodstocked fish spawned naturally?
5. What effect do Snider Creek steelhead mixing on the spawning grounds with naturally produced steelhead have on the genetics and productivity of the natural population?

Various assumptions must to be made to allow the data to address the questions posed. Many are commonly made when working with sampling data. Some are discussed in this paper, others are annotated within the data. The data are available upon request.

Contribution of Snider Creek production to the sport and tribal fisheries

Through the years, both sport and tribal fisheries were sampled regularly for Snider Creek-origin steelhead returns, which are identified by a left ventral fin clip given to all released Snider Creek-origin smolts. Assuming the sampled catch was representative of the full catch, samples were expanded to estimate total catch of Snider Creek steelhead for each fishery. Results varied widely from year to year depending on the numbers of returning fish, and the number of fishable days, especially for the sport fishery. The estimated sport harvest averaged 92 Snider Creek-origin steelhead per season over the database, and 131 since the ‘99/’00 season, with a high of 293 during the ‘09/’10 season. Early indications are that the ‘10/’11 season is another year of strong catches.

The Quileute Tribe’s gillnet fishery averaged 37 Snider Creek steelhead per season; 48 since the ‘99/’00 season, with a high of 124, taken in ‘09/’10. The values calculated for gillnet and sport catches are likely to be biased lower than actual catches because of the location of the fin that was removed; fish must be turned over to view the ventral fin, versus the typical adipose fin sampling indicating hatchery or wild. Any mistake would likely decrease the number of clips found. In addition, catch information provided by a small number of guides fishing the Sol Duc suggests that in recent years more Snider Creek-origin fish are being encountered and harvested than indicated by WDFW creel sampling. Prior to the ‘03/’04 season, WDFW’s Quillayute River creel survey was designed to randomly sample the sport catch and effort, and estimate total catches by week. Since that time the creel survey has been reduced and re-designed to collect biological data from as many steelhead as the sampler can access. As such, the sampling data from the later years does not necessarily satisfy the random assumption necessary for accurate expansions, and may be under-reporting the presence of Snider Creek-origin steelhead in the sport catch.

Table 1. Estimated catches of Snider Creek-origin steelhead.

Season	Treaty Gillnet	Sport Catch	Total Catch
91-92	14	33	47
92-93	50	117	167
93-94	6	15	22
94-95	27	43	70
95-96	7	34	41
96-97	11	19	30
97-98	8	20	28
98-99	43	30	73

99-00	82	216	297
00-01	79	182	262
01-02	19	241	260
02-03	8	42	51
03-04	7	80	87
04-05	17	40	57
05-06	32	59	91
06-07	65	127	193
07-08	17	74	92
08-09	79	85	164
09-10	124	293	417
Mean	37	92	129
Min.	6	15	22
Max.	124	293	417

Return timing of Snider Creek Steelhead

Broodstock collection for the Snider Creek steelhead program targeted captures before February 1 to draw from the early returning portion of the wild run, as a means of supplementing this portion of the run with any program steelhead that escape fisheries and spawn in the wild. Sampling data in both the gillnet and sport fisheries confirms that peak entry for the returning Snider Creek steelhead occurs in January, suggesting that the program effectively targets the earlier returning component of the wild return.

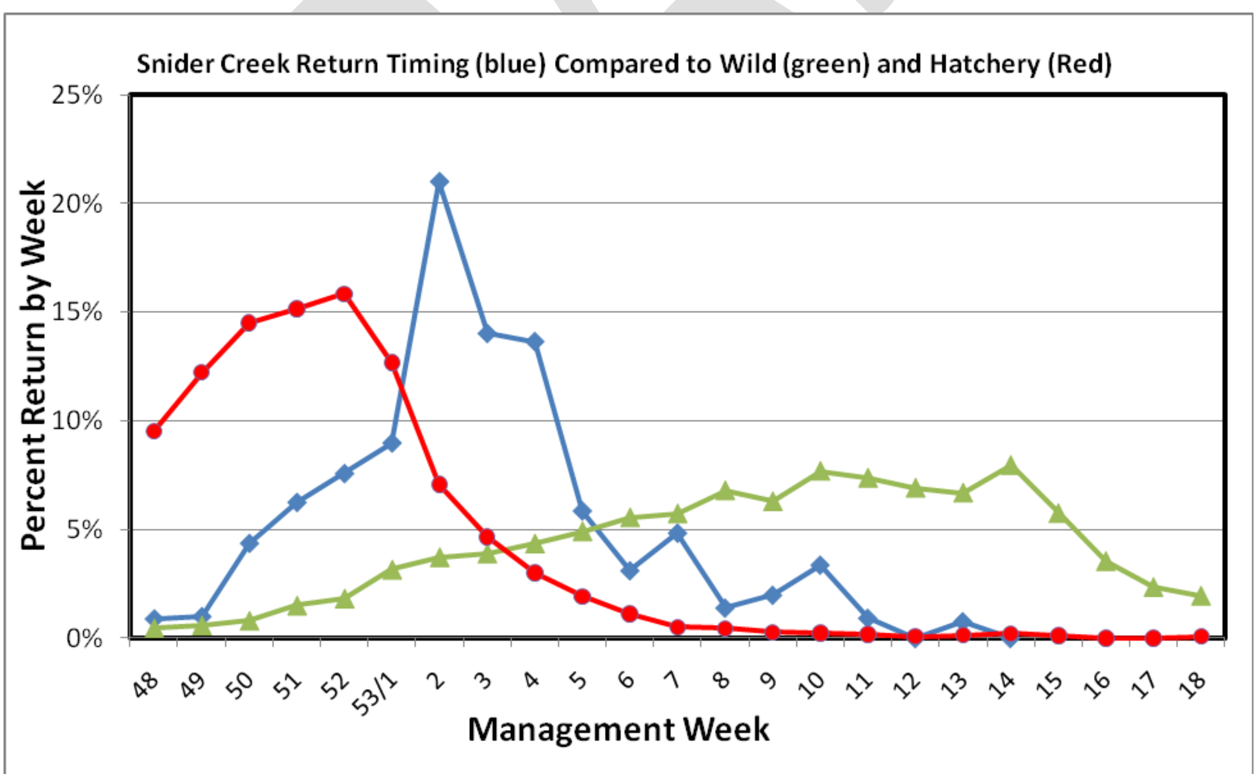

Figure 1. Timing of Snider Creek, Bogachiel Hatchery, and wild steelhead catch in the tribal gillnet fishery.

Proportion of the early timed Sol Duc River wild steelhead being removed for broodstock

Broodstocking wild steelhead enables the Snider Creek program to produce a return of adult steelhead that have had only one generation of rearing in a hatchery environment and only to the smolt stage. Such a program is designed to minimize the influence, both genetically and behaviorally, of the returning program adults on wild steelhead that they may mix with on the spawning grounds. If the proportion being removed by broodstocking activities is small, the impact of such a program is likely much reduced over a situation where a large proportion of the early timed wild stock is being removed. Table 2 presents the number of broodstocked steelhead each year. Not all these fish were actually spawned; some died before spawning, some were released without being spawned, generally because they failed to ripen early enough for incorporation into the program. Regardless, all broodstock collected are used in this analysis, producing an estimate bias to the high side of the probable proportion of wild fish removed for use in the program.

Table 2. Proportion of wild early timed (through week 5) steelhead removed for Snider Creek program broodstock.

Return Year	Broodstocked Steelhead	Sol Duc Escapement Total	Sol Duc Escapement Early (thru wk 5)	Broodstocked % of Total	Broodstocked % of Early
1991-92	34	2,295	582	1.48%	5.52%
1992-93	39	2,711	687	1.44%	5.37%
1993-94	33	4,191	1,062	0.79%	3.01%
1994-95	61	5,124	1,298	1.19%	4.49%
1995-96	66	6,845	1,735	0.96%	3.67%
1996-97	57	4,764	1,207	1.20%	4.51%
1997-98	41	7,634	1,934	0.54%	2.08%
1998-99	45	6,973	1,767	0.65%	2.48%
1999-00	46	5,416	1,372	0.85%	3.24%
2000-01	45	4,575	1,159	0.98%	3.74%
2001-02	45	4,546	1,152	0.99%	3.76%
2002-03	37	3,673	931	1.01%	3.82%
2003-04	42	5,110	1,295	0.82%	3.14%
2004-05	56	3,602	913	1.55%	5.78%
2005-06	55	4,718	1,196	1.17%	4.40%
2006-07	42	2,819	714	1.49%	5.55%
2007-08	45	3,448	874	1.31%	4.90%
2008-09	38	1,791	454	2.12%	7.73%
2009-10	62	2,949	747	2.10%	7.66%
Mean:	46.8	4,378	1,109	1.19%	4.47%
High:	66		1,934	2.12%	7.73%
Low:	33		454	0.54%	2.08%

On average, 47 wild-origin steelhead were removed for broodstock each year during the latter half of January for the Snider Creek program. To determine what proportion of the early-timed wild escapement those 47 fish represent, the number of early-timed wild steelhead returning to the Sol Duc was estimated. The total escapement in the Sol Duc of wild-origin steelhead is estimated annually, but the proportion that returns to the river during the time the Snider Creek-origin fish are returning is not available through that sampling scheme. However, the Quileute Tribe's gillnet fishery provides a means of estimating the proportion of the wild run that is available weekly in the lower river, which provides a good estimate of entry timing. The gillnet fishery "wild catch coefficients" used, along with expected effort, to predict the fishery's catch in any given week, are based on the proportion of the run available to the fishery by week. These are long term averages, and are the data used to construct the timing curve for wild steelhead in Figure 1. This timing curve indicates that by the end of statistical week five, which generally correlates with the end of January, 25.3% of the wild return has entered the Quillayute River. In contrast, through statistical week five most Snider Creek-origin steelhead (83.6%) have returned to the river. The estimated number of early wild-origin steelhead entering the system by the end of January, (when broodstocking activity ceases), and the percent of these early timed steelhead that have been removed for broodstock, are presented in Table 2. The percent removed of the early timed steelhead has ranged from about 2% to 8% (Table 2).

Production from Snider Creek program compared to foregone natural production

One of the costs of a wild broodstocking program is the loss of the wild production that might have resulted from those broodstocked steelhead had they spawned in the wild. Estimating the return of adults per parent spawner for the broodstocked steelhead hatched and reared for a year in the hatchery prior to release, and comparing it to a similar measure for the wild stock, provides a picture of what the wild population is giving up in wild spawners. Comparing that with the estimates of Snider Creek-origin steelhead that escape to spawn in the wild will provide one measure of the net effect of the Snider Creek program on wild steelhead numbers.

Escapement estimates are constructed annually for the Quillayute System wild stock and the early timed Bogachiel hatchery stock. Because estimates of harvests from the sport and tribal gill net fisheries are also available, we estimate the total return, or run size, for these stocks. We have no means of directly estimating the escapement piece of the Snider Creek-origin steelhead, but by assuming a harvest rate on Snider Creek steelhead, we can calculate the escapement piece of the return. Because the timing of the Snider Creek-origin steelhead is intermediate between the Bogachiel hatchery and wild stock returns, the annual harvest rate for the combined wild and hatchery stocks was used to estimate the escapement piece of the Snider Creek-origin steelhead.

Table 3 indicates that in all years the production of adult recruits from the broodstocked Snider Creek steelhead exceeded that which could have been expected from natural production. The number of broodstocked early wild steelhead that were spawned ranged from 13 to 59 (doesn't include mortalities or those released without spawning), and produced an average of 8.88 recruits per spawner. The wild population during the approximate same period averaged 1.37 recruits per spawner. The Snider program production provided additional harvest benefits by sport and tribal fisheries, and increased spawning numbers of early timed steelhead in all but 2 years.

Table 3. Comparison of Snider Creek production and potential wild production that would have gone into escapement had the broodstocked wild steelhead been allowed to spawn naturally.

Snider Creek Program Production						Wild Production	
Brood Year	Brood-Stock	Recruits / Spawner	Recruits	Brood Catch	Brood Escapement	Recruits / Spawner	Potential Recruits
1988	25					1.19	30
1989	27	4.84	131	81	50	0.67	18
1990	13	15.08	196	118	79	1.35	18
1991	15	6.16	92	40	52	2.45	37
1992	30	4.79	144	64	80	3.16	95
1993	35	2.96	104	35	68	2.78	97
1994	20	6.53	131	35	95	2.13	43
1995	59	3.38	200	53	147	1.71	101
1996	53	3.75	199	72	127	1.37	72
1997	45	18.55	835	293	542	1.24	56
1998	28	24.55	687	310	377	0.86	24
1999	37	12.57	465	210	255	0.61	23
2000	38	4.66	177	65	112	1.08	41
2001	38	4.74	180	67	114	0.70	27
2002	35	7.50	262	93	169	0.97	34
2003	24	18.14	435	192	244	1.05	25
2004	36	4.99	180	73	106	0.68	25
2005	48	5.21	250	95	155	0.72	35
2006	50	11.44	572	243	328		
Mean:	35	8.88	291	119	172	1.37	44
Minimum:	13	2.96	92	35	50	0.61	18
Maximum:	59	24.55	835	310	542	3.16	101

Possible influences of Snider Creek steelhead mixing with wild steelhead.

A number of concerns are associated with hatchery steelhead mixing with wild steelhead on the spawning grounds, including their possible influence on the health, genetic makeup, and productivity of the wild population.

<u>Juvenile interactions</u>

Scale analysis revealed a small proportion of Snider program returning adults spent two years in fresh water, rather than the one year that characterizes most hatchery adults, including most Snider Creek-origin fish (Table 4). Several explanations are possible: 1) a portion of the smolts released may be choosing to stay in the river for an extra year or two before migrating; 2) a small number of wild steelhead are being sampled because of the occurrence of naturally missing ventral fins (wild steelhead spend 1 to 4 years in freshwater, with 2 years predominating); 3) scale reading errors; and 4) a combination of causes. After review by the WDFW scale reading lab, the most likely explanation is that these hatchery-origin fish delayed their migration and remained in the river, rearing for another year rather than migrating directly to the ocean upon release. This is a concern because of potential interactions between juvenile wild and hatchery steelhead after release that may negatively influence the wild population through increased competition for food and habitat, and possible predation or transmission of diseases. This data set is limited and only includes release years 2000 through 2006 because too few scales were sampled prior to release year 2000 to make reliable estimates of the proportion that delayed migration, and releases after 2006 have not completed their return. On average almost 11% of the returning adults from releases during the years examined delayed migration for at least a year after release. The actual proportion of releases delaying migration is likely larger because the 11% doesn't include those that died during the extra freshwater residence, nor does it count any that may fully residualize and remain in the river, adopting a resident trout life history.

Table 4. Number and size of Snider program releases (fpp) and proportion of returning steelhead by release year that spent more than one year in fresh water.

Smolt release year (brood year + 1)	Smolt size at release (fish/lb.)	Returns from Non-yearling Out-Migrants	Total Brood Return	% non-yearling Returns of Total Returns
2000	7.5	51	465	11.0%
2001	8	25	177	14.4%
2002	5.5	0	180	0.0%
2003	17	31	262	12.0%
2004	7.3	40	435	9.3%
2005	10	29	180	15.9%
2006	12	30	250	12.0%
2007	10.5	15	572	
2008	8.9			
2009	7.7			
2010	10.8			
Mean:				10.64%

One of the potential causes of delayed migration is releasing smaller than ideal steelhead smolts. The Bogachiel Hatchery targets five fish per pound for its winter steelhead releases. In recent years only one release from Snider Creek approximates that size. This apparent difficulty in getting the Snider Creek program fish to size may be contributing to the number of fish that delay their migration after release. Another factor may be that because Snider fish are progeny of broodstocked wild steelhead, some may still be predisposed toward exhibiting the wild life history pattern in which a majority of steelhead smolt at age 2.

<u>Adult interactions</u>

The effect on wild populations of interbreeding with hatchery fish has been widely discussed and studied. One prominent finding reaching general consensus is that hatchery fish spawning in the wild produce fewer adult offspring than their wild counterparts (lower productivity). Further, when a hatchery fish crosses with a wild, their productivity is again depressed compared to wild, generally to a rate intermediate between straight wild and straight hatchery pairings. The impact of a program like Snider Creek, however, that limits broodstock to one generation in the hatchery, is not yet clear. Araki et.al., 2007, working with Hood River wild winter steelhead and a hatchery stock that spent only one generation in the hatchery, have measured and compared the productivity of wild, hatchery, and wild x hatchery pairings using genetic analyses to identify parents. They found that over six return years the wild x hatchery produced at a rate of about 85% of the straight wild pairs, though results varied widely from year to year. They found in later work (Araki et.al. 2009) an indication that the lower survival associated with the one-time hatchery spawners that crossed with a wild steelhead may actually linger to a lesser degree in second generation spawning in the wild.

These results suggest that Snider Creek program steelhead escaping to the wild may negatively affect the productivity of the Sol Duc wild population. The number of Snider Creek-origin steelhead escaping to the wild, and the proportion they make up of the naturally spawning population they may affect, are needed in order to assess their possible impact. Because Snider Creek-origin steelhead enter the system earlier than the bulk of the wild run, and spawn earlier than the peak wild timing, they are more likely to impact only that portion of the wild run that corresponds to their timing. Entry timing and spawn timing appear to be correlated, at least in a general sense. WDFW’s early-timed Bogachiel hatchery stock spawns before the end of January, and the early wild steelhead caught in January for Snider Creek broodstock are spawned February through early-April, peaking in March, well before the peak spawning of the wild stock in late-April. From the timing curves presented in Figure 1, 25.3% of the wild-origin steelhead and 83.6% of the returning Snider Creek-origin steelhead have entered the river by statistical week five.

The number of Snider Creek-origin and Sol Duc wild-origin steelhead that enter the Quillayute system through statistical week five and escape to spawn, and the proportion of the total escapement and early escapement that are Snider Creek-origin, are presented in Table 5.

Table 5. Estimated Snider Creek program and Sol Duc wild steelhead escapements with similar entry timing, and the proportion of these that are of Snider program origin.

Return	Sol Duc Escapement		Snider Cr. Escapement		% Snider	
Year	Total*	thru wk 5 ^	Total**	thru wk 5 ^	of Total	thru wk 5
1991-92	2,295	582	28	24	1.23%	3.91%
1992-93	2,711	687	101	85	3.73%	10.96%
1993-94	4,191	1,062	30	25	0.71%	2.30%
1994-95	5,124	1,298	80	67	1.56%	4.89%
1995-96	6,845	1,735	65	54	0.95%	3.04%
1996-97	4,764	1,207	38	31	0.79%	2.54%
1997-98	7,634	1,934	158	132	2.07%	6.41%
1998-99	6,973	1,767	136	114	1.95%	6.04%
1999-00	5,416	1,372	566	474	10.45%	25.65%
2000-01	4,575	1,159	325	272	7.10%	18.99%
2001-02	4,546	1,152	293	245	6.45%	17.55%
2002-03	3,673	931	88	74	2.40%	7.34%

2003-04	5,110	1,295	129	108	2.53%	7.72%
2004-05	3,602	913	121	101	3.35%	9.96%
2005-06	4,718	1,196	183	153	3.88%	11.34%
2006-07	2,819	714	189	158	6.71%	18.14%
2007-08	3,448	874	175	146	5.07%	14.33%
2008-09	1,791	454	259	216	14.44%	32.27%
2009-10	2,949	747	465	389	15.78%	34.24%
Mean:	4,378.1	1,109.4	180.5	151.0	4.80%	12.51%
High:		1,934		474	15.78%	34.24%
Low:		453.8		24	0.71%	2.30%

Population fitness effects

Hatchery-origin fish interacting with wild-origin fish on the natural spawning grounds can have genetic consequences as well as affect the reproductive success of the wild stock, as stated above. Successful hatchery-origin spawners can bring with them the negative effects of domestication that, when successfully passed on can impart mal-adapted traits to the progeny. If this occurs at a high enough frequency, the traits of the wild population can become less than optimal for their environment, leaving the population less adaptable to frequent or infrequent environmental perturbations.

The Hatchery Scientific Review Group (HSRG) has developed a series of metrics used to help assess the risk of these effects. Using the proportion of the total hatchery broodstock made up of wild fish and the proportion of the naturally spawning population that is hatchery fish, a PNI (Proportionate Natural Influence) can be calculated. PNI is used to analyze the influence of an integrated hatchery population, like the Snider Creek program, on the Sol Duc wild winter steelhead. The closer this number is to 1.0, the less theoretical risk there is to the genetic and trait characteristics of the wild population.

The All-H Analyzer (AHA) is a model developed by the HSRG to look at various aspects of the relationship between hatchery and wild fish. One of its output metrics is PNI. Figure 2 shows the results of two different model runs for the Snider Creek hatchery program and its interaction with the Sol Duc steelhead. One scenario represents the current program based on the last ten years of performance. The second scenario looks at the hatchery program and its interaction with only the early component of the Sol Duc wild steelhead. In both cases, the estimated PNI, 0.94 and 0.84 respectively, is significantly higher than the HSRG goal (0.67) for highly important natural populations (primary).

Sol Duc Steelhead- Snider Creek Program			
Natural Production	Current Total Sol Duc Wild Run	A Primary Population Biological Targets	Current Early portion Wild Run
Productivity (Smolts/Spawner)	14		14
Capacity (Smolts)	109292		26355
SAR	11.8%		11.8%
Fitness	0.99		0.96
PNI	**0.94**	> 0.67	**0.84**
Total Effective pHOS (EpHOS)	**6%**	< 30%	**19%**
Seg Effective pHOS (SpHOS)	1%	< 5%	3%
Seg Census pHOS (CpHOS)	5%	< 30%	15%
NOR Abundance potential	3509	>	949

Figure 2. AHA model output showing PNI estimates for the current program interacting with the entire Sol Duc winter steelhead population (first column) and with only the early component of the Sol Duc winter steelhead population (last column).

Wild stock gene banks

The Statewide Steelhead Management Plan (2008) provides policies, strategies, and actions for managing the state's steelhead resources. One of the strategies listed under "Natural Production", page 6, is to: "Establish a network of wild stock gene banks across the state where wild stocks are largely protected from the effects of hatchery programs. At least one wild stock gene bank will be established for each major population group in each steelhead DPS."

One of the requirements of a wild stock gene bank is "No releases of hatchery-origin steelhead will occur in streams where spawning of the stock occurs …." The strategy further specifies that in these gene bank streams "Fisheries can be conducted if wild steelhead management objectives are met …." The Distinct Population Segment (DPS) that includes north coastal steelhead is called the "Olympic Peninsula ESU", and extends from west of the Elwha on the Strait of Juan de Fuca, west and south to the Copalis River just south of the Quinault River. Major steelhead populations occur in the Quinault, Queets, Hoh, and Quillayute systems, with additional smaller stocks associated with other small independent drainages.

Within the Quillayute System, the Sol Duc wild steelhead represent the best option for a designated wild winter steelhead gene bank. The Sol Duc River is home to Washington State's largest unlisted wild winter steelhead stock. With its headwaters in the Olympic National Park, the upper 20 or so mainstem river miles are largely protected from adverse human activities. Wild steelhead release and selective gear rules (no bait, barbless hooks, …) are required in all waters upstream of the Sol Duc hatchery at river mile 30, and the upper 21.4 miles of the accessible Sol Duc, from the Highway 101 bridge just downstream of Snider Creek (river mile 43.6) to Sol Duc Falls, is closed to fishing October 31. The Snider Creek rearing facility is located 14 river miles upstream of the Sol Duc Hatchery.

Besides the Snider Creek program releases, the Sol Duc River receives an annual summer steelhead plant of 20,000 smolts, but does not receive any early-timed Bogachiel hatchery steelhead releases.

One other river with characteristics that fit the definition for a wild stock gene bank is the Clearwater River, tributary to the Queets River. The Clearwater has a healthy, stable population with an average annual escapement of 1,900, roughly half that of the Sol Duc (4,100), and it does not receive any plants of hatchery steelhead. However, its headwaters do not extend into the Olympic National Park, and it is subject over time to fairly extensive logging throughout much of its watershed.

Summary of answers to questions

1. *What is the contribution of Snider Creek production to the sport and tribal fisheries?* The Snider Creek program contributes each year to both sport and gillnet fisheries. Contribution rates vary by year. The sport fishery has averaged 131 Snider Creek-origin steelhead per year since the '99/'00 season, with a range of 40 to 293. The Quileute Tribes gillnet fishery averaged 47 during the same time frame, with a high of 124. Indications are that the 2010/11 season has produced catches in both fisheries exceeding the previous highs (Table 1).

2. *Is the Snider Creek program producing early timed returns, as intended?* The return of Snider Creek program steelhead peaks in January, well ahead of the peak wild steelhead return in March. The program appears to successfully produce early returning steelhead reflecting the early-timing of the broodstock targeted (Figure 1).

3. *What proportion of the early timed Sol Duc River natural steelhead return is being removed for broodstock?* The number of wild early-timed steelhead being removed from the Sol Duc River for broodstock is estimated to be consistently less than 10% of the early wild steelhead entering the river. Estimates averaged 4.5%, with a high of 7.8% (Table 2).

4. *How does the production from the program compare to the production that could be expected had the broodstocked fish spawned naturally?* In all years the production of adult recruits from the broodstocked Snider Creek steelhead exceeded that which could have been expected from natural production. The Snider Creek program production provided additional harvest by sport and tribal fisheries, and increased spawning numbers of early timed steelhead in all but two years (Table 3).

5. *What effect do Snider Creek steelhead mixing on the spawning grounds with naturally produced steelhead have on the genetics and productivity of the natural population?*
<u>Juvenile interactions</u>. Scales indicate that almost 11% of returning adults spent two or more years in fresh water (Table 4). The proportion of releases delaying migration is somewhat higher than 11% because those that delayed migration but died before entering the ocean, or that residualized and did not migrate, are not included in the 11%. Causes may be smaller size at

release than optimum, and/or the predisposition of wild broodstock to spend multiple years in freshwater. Delayed migration raises concerns about competition with, and/or predation upon rearing wild juveniles, as well as possible vectors for spread of diseases from the hatchery environment.

Adult interactions. Hatchery steelhead mixing on the spawning ground with wild steelhead can negatively affect the spawning productivity of the wild stock. This can occur from negative genetic or behavioral traits passed to progeny. The AHA model was used to assess the potential negative impact of the Snider Creek program fish on the Sol Duc wild population. Within the guidelines established by the HSRG review, the Snider Creek program production's influence measured by PNI on the entire Sol Duc wild winter escapement, and on a smaller early timed piece of the escapement, was well within the acceptable range, with PNI values of 0.94, and 0.84, respectively. The HSRG goal is a PNI value above 0.67 for highly important natural populations (Figure 2).

Management Options

The analyses performed to evaluate the Snider Creek steelhead program reveal that the program as measured is meeting its intended purpose of providing additional fish for harvest. It is also contributing to early-timed steelhead escapement at a level deemed acceptable by the AHA modeling conducted to assess it. Concerns were raised regarding the apparent delay in seaward migration by a portion of the released Snider Creek program juveniles, and their possible affect on rearing wild steelhead juveniles.

WDFW fisheries managers are also mandated by the Statewide Steelhead Management Plan to establish wild stock gene banks "for each major population group in each steelhead DPS", and waters designated as such may not receive plants of hatchery steelhead. Clarifying the definition of a "major population group" will help in understanding and implementing this management strategy.

Given these considerations, the management options presented in Table 6 were identified for consideration regarding the Snider Creek steelhead program and the Sol Duc River's wild steelhead population.

Table 6. Management options considered for the Snider Creek Steelhead program and the Sol Duc River's wild steelhead population.

Option	Action	Comments
1	▪ Create a "Wild Stock Gene Bank" in the Clearwater ▪ Eliminate the Snider Creek Project ▪ Create a "Wild Stock Gene Bank" in the Sol Duc	• Clearwater R. does not receive hatchery plants. • Sol Duc receives 20K summer steelhead plus about 50K Snider. • Sol Duc has State's largest unlisted wild winter steelhead stock.
2	▪ Create a "Wild Stock Gene Bank" in the Clearwater ▪ Re-locate the Snider Creek Project to the Calawah ▪ Create a "Wild Stock Gene Bank" in the Sol Duc	• Calawah currently receives 50K early timed Bogachiel (Chambers Creek) winter, and 30K Skamania summer steelhead. • Available rearing space would need to be confirmed.
3	▪ Create a "Wild Stock Gene Bank" in the Clearwater ▪ Re-new the Snider Creek Project "as is"	• Current Snider agreement: o 100K release o Right to expand with 50K each in Bogachiel and Calawah. • "Renew as is" option assumed at 50K, and only at current site.
4	▪ Create a "Wild Stock Gene Bank" in the Clearwater ▪ Re-new the Snider Creek Project With Additional Requirements	• Potential changes to program: • 25 K release • Improve rearing to appropriate size • Install adult trap at Snider • Require log books from guides • Other ???

Notes:

1. Watershed sizes:

Square miles:	Sol Duc = 226	Clearwater = 153
Mainstem miles:	Sol Duc = 65 to falls	Clearwater = 36

2. Current sport regulations include the Sol Duc and Clearwater in the list of streams from which an angler may take his one wild steelhead per year: Sol Duc below hatchery at river mile 30; Clearwater below mouth of Snahapish at river mile 18.3.

3. Selective gear rules are currently required in the upper Sol Duc from hatchery to bridge below Snider Cr. (r.m. 30 – 43.6) Nov. 1 – Apr 30, and throughout the opening of the river above (June – Oct). Selective gear rules are not currently required in the Clearwater.

References:

Araki, H., Becky Cooper, and Michael S. Blouin. 2007. Genetic Effects of Captive Breeding Cause a Rapid, Cumulative Fitness Decline in the Wild. Science, Vol. 318, pp 100-103.

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Appendix 1. Hatchery Production associated with SaSI Steelhead Stocks for Strait of Juan de Fuca West of Elwha and Coast North of Grays Harbor

WRIA 19		Plants	Status
Salt Creek/Independents Winter Steelhead	Winter		
Lyre Winter Steelhead	Winter	25K winters, 10K summers	discontinued after 2009
Pysht/Independents Winter Steelhead	Winter	10K	discontinued after 2009
Clallam Winter Steelhead	Winter	10K	discontinued after 2009
Hoko Winter Steelhead	Winter	25K	Active
Sekiu Winter Steelhead	Winter	10K	Active
Sail Winter Steelhead	Winter	5-8K	Active
WRIA 20		**Plants**	**Status**
Sooes/Waatch Winter Steelhead	Winter	140-170K	Active
Ozette Winter Steelhead	Winter		
Quillayute/Bogachiel Summer Steelhead	Summer		
Quillayute/Bogachiel Winter Steelhead	Winter	100K	Active
Dickey Winter Steelhead	Winter		
Sol Duc Summer Steelhead	Summer	20K	Active
Sol Duc Winter Steelhead	Winter	Snider Cr. - 50K	????
Calawah Summer Steelhead	Summer	40K	Active
Calawah Winter Steelhead	Winter	50K	Active
Goodman Creek Winter Steelhead	Winter	20K	discontinued after 2009
Mosquito Creek Winter Steelhead	Winter		
Hoh Summer Steelhead	Summer		
Hoh Winter Steelhead	Winter	100K	Active
WRIA 21		**Plants**	**Status**
Kalaloch Creek Winter Steelhead	Winter		
Queets Summer Steelhead	Summer		
Queets Winter Steelhead	Winter		
Clearwater Summer Steelhead	Summer		
Clearwater Winter Steelhead	Winter		
Salmon River Winter Steelhead (non-SaSI)	Winter	150K	Active
Raft Winter Steelhead	Winter		
Quinault Summer Steelhead	Summer		
Upper Quinault Winter Steelhead	Winter	~15K	occasional
Lower Quinault Winter Steelhead	Winter	~200K	Active
Moclips Winter Steelhead	Winter	15-30K	occasional
Copalis Winter Steelhead	Winter		

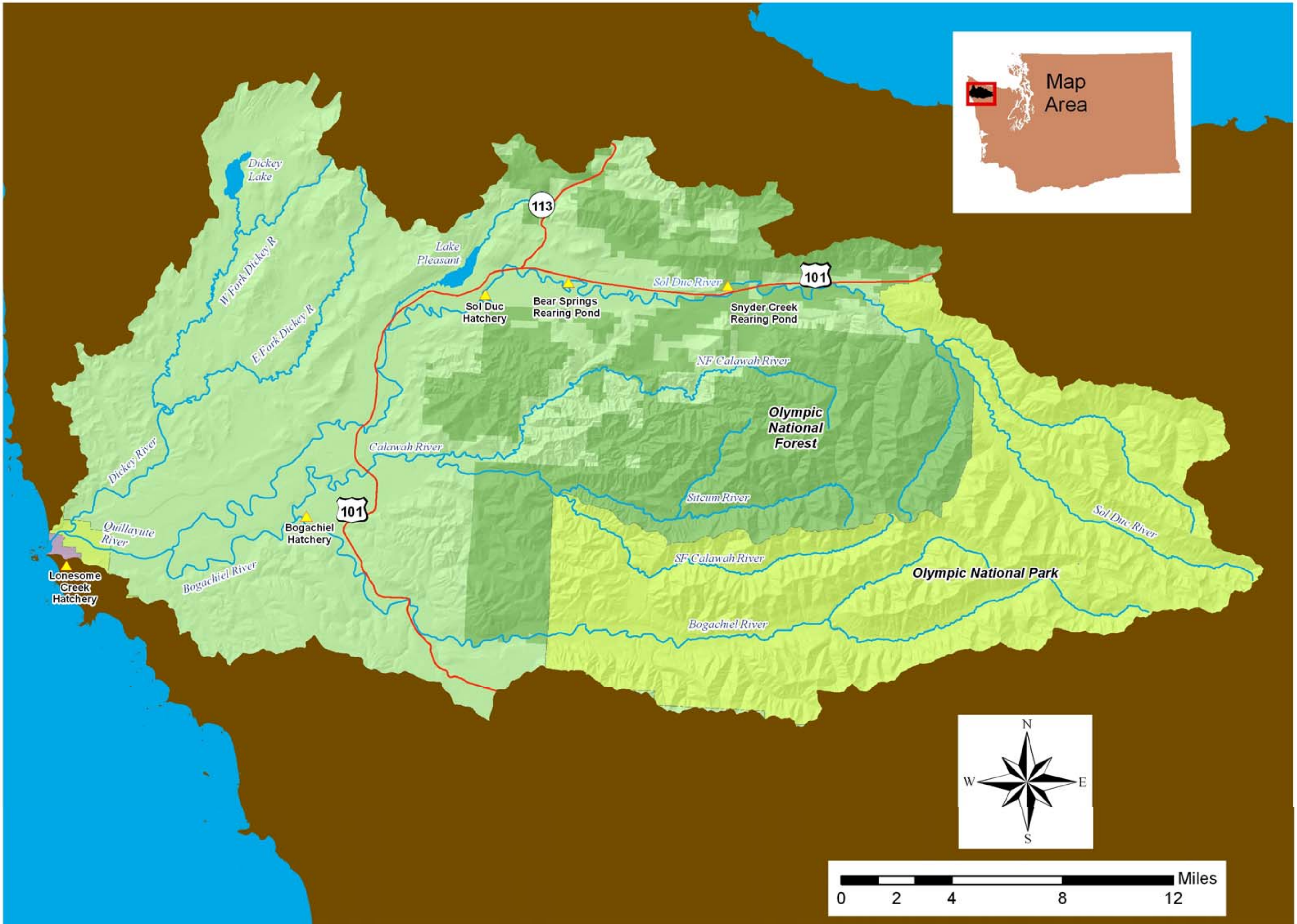
Appendix 2. Winter Steelhead Escapements by Tributary and Run Sizes by System for the Queets and Quillayute River Systems

Wild Steelhead Escapement for the Queets System by River.

Year	Escapements: Clearwater	Queets	System	Run Size
1980	3,444	4,771	8,215	
1981	2,848	4,170	7,018	13,309
1982	2,508	3,824	6,332	10,284
1983	1,758	2,864	4,622	8,525
1984	1,638	2,248	3,886	7,165
1985	2,262	2,978	5,240	10,376
1986	1,816	3,186	5,002	9,148
1987	2,203	3,323	5,526	10,775
1988	2,363	2,981	5,344	10,376
1989	2,178	3,142	5,320	9,145
1990	1,735	2,973	4,708	8,237
1991	1,807	3,387	5,194	8,312
1992	2,662	4,421	7,083	12,060
1993	2,299	4,578	6,877	11,268
1994	1,405	4,678	6,083	8,467
1995	1,414	1,990	3,404	5,599
1996	847	1,424	2,271	5,024
1997	1,070	2,260	3,330	5,441
1998	1,699	1,930	3,629	5,103
1999	1,018	2,080	3,098	5,413
2000	1,580	2,682	4,262	6,110
2001	1,368	3,574	4,942	7,212
2002	1,385	3,571	4,955	5,531
2003	1,261	1,910	3,171	4,883
2004	2,966	4,875	7,841	9,472
2005	2,327	4,149	6,476	7,744
2006	1,665	5,388	7,053	8,260
2007	1,759	3,420	5,179	6,979
2008	2,270	2,496	4,766	5,903
2009				5,374
2010				6,754
Escapement Goal: 4,200 (WDFW)				
Avg.:	1,916		5,201	8,076
High:	3,444		8,215	13,309
Low:	847		2,271	4,883

Wild Steelhead Escapement for the Quillayute System by River.

Year	Escapements: Quillayute/ Bogachiel	Sol Duc	Calawah	Dickey	System	Run Size
1978	1,887	4,040	1,813	563	8,303	10,031
1979	1,222	1,967	1,562	336	5,087	7,555
1980	1,228	3,477	989	312	6,006	8,671
1981	1,587	4,170	2,384	429	8,570	11,044
1982	2,428	4,712	2,913	1,607	11,660	15,144
1983	2,163	3,509	2,521	568	8,761	10,774
1984	2,892	4,127	3,220	430	10,669	13,245
1985	1,576	2,504	2,191	405	6,676	11,260
1986	2,501	4,046	3,480	719	10,746	14,381
1987	2,569	4,105	2,994	332	10,000	14,994
1988	3,381	4,099	4,526	179	12,185	19,746
1989	4,553	5,333	3,556	606	14,048	19,635
1990	1,680	3,289	2,573	554	8,096	13,108
1991	1,642	3,551	2,046	419	7,658	12,352
1992	973	2,295	1,957	310	5,535	12,134
1993	1,329	2,711	1,945	285	6,270	13,370
1994	1,491	4,191	1,458	143	7,283	10,984
1995	2,050	5,124	3,375	377	10,926	16,780
1996	2,208	6,845	5,558	580	15,191	21,615
1997	1,596	4,764	3,607	591	10,558	16,487
1998	3,320	7,634	5,124	871	16,949	18,896
1999	3,465	6,973	5,210	854	16,502	21,021
2000	3,214	5,416	5,411	624	14,665	20,479
2001	3,112	4,575	4,413	483	12,583	19,809
2002	1,964	4,546	3,990	742	11,242	15,665
2003	1,854	3,673	2,850	347	8,724	12,123
2004	2,163	5,110	3,773	418	11,464	15,438
2005	2,224	3,602	2,602	405	8,833	11,661
2006	2,583	4,718	3,371	385	11,057	13,526
2007	1,293	2,819	3,144	214	7,470	11,697
2008	1,526	3,448	2,911	443	8,328	11,221
2009	895	1,791	1,875	172	4,733	6,786
2010	1,491	2,949	2,618	490	7,548	10,370
Goal:	1,127	2,910	1,740	123	5,900	
Avg.:	2,123	4,125	3,090	491	9,828	14,000
High:	4,553	7,634	5,558	1,607	16,949	21,615
Low:	895	1,791	989	143	4,733	6,786



Map
Area
Dickey Lake
W Fork Dickey R
E Fork Dickey R
Lake Pleasant
113
101
Sol Duc River
Sol Duc Hatchery
Bear Springs Rearing Pond
Snyder Creek Rearing Pond
NF Calawah River
Olympic National Forest
Calawah River
Dickey River
Sitcum River
Sol Duc River
Quillayute River
Bogachiel Hatchery
SF Calawah River
Olympic National Park
Lonesome Creek Hatchery
Bogachiel River
Bogachiel River
N
W
E
S
Miles
0 2 4 8 12

Wild Steelhead Retention and Release Areas 2010-11